

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 02 May 2001 (02.05.01)	
International application No. PCT/GB00/03239	Applicant's or agent's file reference P007482WO
International filing date (day/month/year) 18 August 2000 (18.08.00)	Priority date (day/month/year) 20 August 1999 (20.08.99)
Applicant JHOOTI, Permjit et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 10 March 2001 (10.03.01)

☐ in a notice effecting later election filed with the International Bureau on:



2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Zakaria EL KHODARY Telephone No.: (41-22) 338.83.38
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P07482WO		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/03239	International filing date (day/month/year) 18/08/2000	Priority date (day/month/year) 20/08/1999	
International Patent Classification (IPC) or national classification and IPC G01R33/567			
Applicant Imperial College Innovations Limited			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 7 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none">I <input checked="" type="checkbox"/> Basis of the reportII <input type="checkbox"/> PriorityIII <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicabilityIV <input type="checkbox"/> Lack of unity of inventionV <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statementVI <input type="checkbox"/> Certain documents citedVII <input checked="" type="checkbox"/> Certain defects in the international applicationVIII <input checked="" type="checkbox"/> Certain observations on the international application			
Date of submission of the demand 10/03/2001		Date of completion of this report 16.11.2001	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer Lersch, W Telephone No. +49 89 2399 2531 	

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03239

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-20 as originally filed

Claims, No.:

1-11 as originally filed

Drawings, sheets:

1-11 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/03239

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	8,9
	No:	Claims	1-7,10,11
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-11
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

**2. Citations and explanations
see separate sheet**

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

ad VII:

The independent claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (e.g., document D1, see below) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

ad V and VIII:

1.) Claims 1, 10 and 11

Claim 1 and, likewise, the other independent claims 10 and 11 would appear to satisfy neither the requirements of Article 33 PCT nor those of Article 6 PCT for the following reasons (only claim 1 is specifically considered below).

- 1.1 Claim 1, due to its extremely broad scope which covers far more than the PAWS technique presented in the description, plainly reads onto the prior art. For instance, in the apparatus disclosed in document D1 (= Magn.Res.Med. 41, 1999, 148-155), too, each line of imaging data is classified into one of a plurality of groups of lines in dependence upon the position of the diaphragm during the breathing cycle, and each group of lines corresponds to one of a plurality of contiguous ranges of position of the diaphragm (see D1, e.g., fig. 2 and the corresponding description). Furthermore, in the apparatus according to D1, too, the scan is terminated when "two or more", i.e. a plurality of, groups of lines corresponding to contiguous ranges of position together contain sufficient data for the reconstruction of an image.

It is noted that the broad scope of claim 1 covers also other conventional techniques, like for instance the ROPE technique.

- 1.2 Moreover, the scope of claim 1 includes also techniques which clearly do not provide the desired technical effect. For instance, the few features that are mentioned in claim 1 by no means guarantee that there is phase ordering (the "P" in "PAWS"), that there is an optimized sequential data acquisition in each bin, that the size of each bin is chosen such as to avoid motion artifacts, that the number of bins is **not** chosen such that the benefits of automatic window selection (the

"AWS" in "PAWS") are entirely lost or that the scan becomes completely inefficient, etc..

- 1.3 Basically, the problem with claim 1 (and the other independent claims) is that many of the essential details which distinguish the PAWS technique from related techniques have been omitted from claim 1 so that the apparatus claimed in claim 1 no longer reflects the characteristics of the PAWS technique. As a consequence also, claim 1 is not supported by the description. For instance, in the preferred 3-bin embodiment according to the description, the scan is terminated when exactly three adjacent bins (or "groups of lines") together contain sufficient data for an image, neither "two" nor "more" than three. This is not at all evident from claim 1: the formulation "two or more groups of lines" includes even the possibility that the scan is terminated only after all of the bins have been filled with a predetermined amount of lines, like for instance in the ROPE technique.
- 1.4 There are also other inconsistencies between claim 1 (as well as the other independent claims) and the description. For instance, the alternative embodiments mentioned on page 11, line 18 - page 12, line 7, page 12, lines 9-18 and page 13, lines 12-16, respectively, of the description would not appear to come within the scope of the claims.
- 1.5 Furthermore, the formulation of claim 1 as such contains obscurities. For instance, it is not clear how the "plurality of groups of lines" comes about when it is sufficient to recover a single line ("at least one line") of imaging data. Furthermore, since a low resolution image can in principle be derived from any number of lines in k-space (even from a single line) the purpose and functioning of the scan terminating logic is obscure.
- 1.6 It thus appears that the independent claims, in order for them to satisfy the requirements of both Article 6 and Article 33 PCT, should be thoroughly amended so as to clearly reflect the features of the PAWS technique.
- 2.) Claim 8
The formulation "when a line of imaging data can be selected to be acquired on either side of k-space corresponding to two different groups of lines" is obscure

since it is not apparent whereto the expression "corresponding to two different groups of lines" refers.

3.) Assessment of the dependent claims with respect to novelty/inventive step

The additional features of claims 2-7 would appear to be known from the prior art referred to above at point 1 as well, whereas the additional features of claims 8 and 9 would appear at least to lack an inventive step with respect to this prior art. However, since it appears possible to render the subject-matter of the independent claims novel and inventive (see above at point 1 and below at point 4) no purpose is seen in elaborating the objections against the dependent claims in any detail.

4.) Assessment of the claims with respect to novelty and inventive step assuming that they have been amended such as to overcome the above objections

Document D1, which is considered to represent the closest prior art, discloses one approach for coping with artifacts in MR images due to respiration and, more specifically, due to changes in the respiratory pattern during an MRI scan. One drawback of this approach is that it relies on the use of a weighted acceptance window. Another one is that it requires the change of gating data in real time on the basis of a continuously updated motion histogram.

The problem facing the invention therefore consisted in developing a technique which allows MRI scans to complete in the shortest possible time, but avoids the drawbacks of the closest prior art.

This problem is solved by the apparatus according to claim 1 (after amendments), the method according to claim 10 (after amendments) and the computer program medium according to claim 11 (after amendments) using an approach in which each motional position is regarded as equally relevant to the final image. The realization that it is possible to devise a data acquisition scheme which enables scans to complete within the shortest possible time but does not rely on operator intervention, nor on the use of a weighted acceptance window, is considered to involve an inventive step.

**INTERNATIONAL PRELIMINARY
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International application No. PCT/GB00/03239

Neither D1 nor any of the other documents cited in the search report contains any suggestion that would have allowed a person of ordinary skill in the art to arrive at the PAWS technique according to the present invention. For instance, both MRM 41 (1999) 555-562 and MRM 38 (1997) 322-333 describe techniques which rely on the selection of the most probable motion state by the operator.

Thus, claims 1-11 would probably satisfy all the requirements of Article 33 PCT if they were amended such as to truly reflect the PAWS technique presented in the description.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P007482W0	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/ 03239	International filing date (day/month/year) 18/08/2000	(Earliest) Priority Date (day/month/year) 20/08/1999
Applicant Imperial College Innovations Limited		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

PHASE ORDERING WITH AUTOMATIC WINDOW SELECTION (PAWS) FOR MOTION RESISTANT MRI

5. With regard to the abstract,

the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

2

None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

A magnetic imaging technique which is resistant to changes in breathing whilst allowing the use of phase ordering to provide effective motion artefact reduction in an optimal time. This is provided by apparatus for magnetic resonance imaging a target object subject to periodic motion, comprising a magnetic resonance imaging scanner for exciting said target object and recovering imaging data in k-space; a sensor for detecting a signal indicative of a position of said target object; classifying logic for classifying said at least one line of imaging data into one of a plurality of groups of lines of imaging data in dependence upon said position detected by said sensor as said target object was excited, each group of lines corresponding to one of a plurality of contiguous ranges of position and scan terminating logic for detecting when two or more groups of lines corresponding to contiguous ranges of position together containing a set of lines of imaging data spanning k-space from which an image can be derived.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03239

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 G01R33/567

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SINKUS R ET AL: "MOTION PATTERN ADAPTED REAL-TIME RESPIRATORY GATING" MAGNETIC RESONANCE IN MEDICINE, US, ACADEMIC PRESS, DULUTH, MN, vol. 41, no. 1, 1999, pages 148-155, XP000799744 ISSN: 0740-3194 see chapters 'MAG Algorithm' and 'Extension of the MAG Algorithm' ---	1-11
A	P.JH00TI ET AL.: "3D Coronary Artery Imaging With Phase Reordering for Improved Scan Efficiency" MAGNETIC RESONANCE IN MEDICINE, vol. 41, 1999, pages 555-562, XP002149700 cited in the application see chapter 'Materials and Methods' --- -/--	1-11



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

10 October 2000

Date of mailing of the international search report

30/10/2000

Name and mailing address of the ISA

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Authorized officer

Lersch, W

INTERNATIONAL SEARCH REPORT

International Application No

T/GB 00/03239

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
"A	<p>WEIGER M ET AL: "MOTION-ADAPTED GATING BASED ON K-SPACE WEIGHTING FOR REDUCTION OF RESPIRATORY MOTION ARTIFACTS" MAGNETIC RESONANCE IN MEDICINE,US,ACADEMIC PRESS, DULUTH, MN, vol. 38, no. 2, 1 August 1997 (1997-08-01), pages 322-333, XP000695508 ISSN: 0740-3194 cited in the application see chapter 'Method'</p> <p>-----</p>	1-11